Notes For Forest Managers

Report #1 November 1999

Using BEHAVE as a Prescribed Fire Planning Tool in Maintaining Oak Savannahs

BEHAVE, a fire behavior prediction system developed by the U.S. Forest Service in the early 1980s, estimates several parameters including fire rate-of-spread (ft/min, chains/hour), flame length (ft), heat per unit area (BTU/sq ft), fireline intensity (BTU/ft/sec), reaction intensity (BTU/sq ft/min) and effective wind speed (miles/hr). Required input data for BEHAVE are minimal: wind speed and direction, percent slope, fuel moisture content and a fuel model number. The predictions and minimal inputs of BEHAVE make this a useful learning and fire management tool. BEHAVE inputs can be easily changed to simulate fire behavior under different conditions. The program is not a substitute for experience, but it does give the inexperienced person an idea of how fire behavior will change when fuel, slope, wind or fuel moisture changes.
Although BEHAVE is a useful learning and fire management tool, BEHAVE s predictions are limited by four assumptions:

1. BEHAVE describes fire behavior in the flaming front only,

2. BEHAVE describes fires advancing steadily, independent of the ignition source,

3. BEHAVE describes fires spreading through surface fuels, and

4. BEHAVE assumes fuel, fuel moisture, wind and slope remain constant during the prediction period.

Assumptions 2 and 4 are frequently violated under prescribed fire situations. Prescribed fires are ignited using techniques which influence fire behavior and reduce the risk of the fire escaping. In addition, fuel and weather conditions may be extremely variable during a fire event.

The purpose of this project was to validate BEHAVE s fire behavior predictions in established oak savannahs using five fuel models. Four of the 13 standardized fuel models evaluated (1-Tall Grass, 2-Timber and Grass, 3-Short Grass and 9-Hardwood Litter) partially fit the fuel characteristics of an established savannah. A Customized Oak Savannah Fuel Model (COSFM) was also developed and evaluated against the BEHAVE models. Fire behavior predictions were evaluated under management conditions which violated Assumption 2 and 4, thereby providing a robust test of the model.

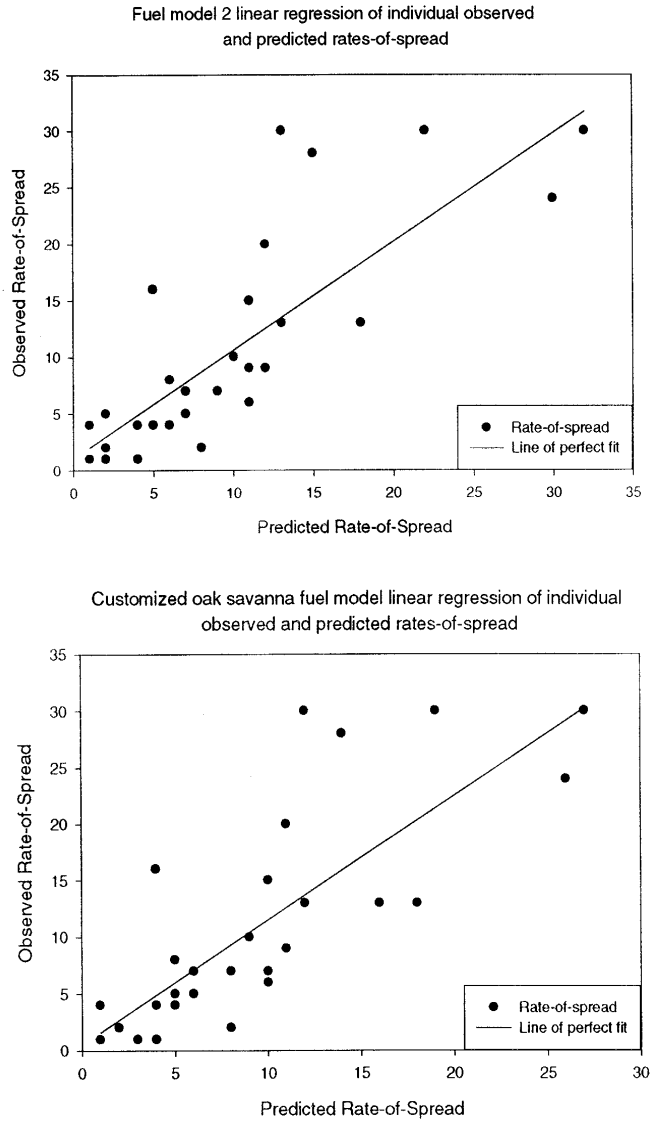
BEHAVE was validated using data from prescribed burns in established savannah communities because these communities are managed with prescribed fire and there is interest in restoring and maintaining this community type in Missouri. For this project, an

ABSTRACT

BEHAVE fire behavior predictions were validated using prescribed fires applied to seven oak savannah sites. Fire behavior was predicted using four standardized and one customized fuel model to determine the most accurate fuel model for oak savannahs. Standardized fuel model 2 (Timber and Grass) and a Customized Oak Savannah fuel model provided the most reasonable fire behavior predictions of the fuel models tested. Standardized fuel model 2 is recommended for use with BEHAVE when predicting fire behavior in established oak savan-

established savannah was defined as: 1) an area that contains a herbaceous layer composed of prairie and forest species, 2) an area with or without a shrub layer, 3) an overstory with between 10 and 80 percent crown closure, and 4) the area has a history of been managed with prescribed fire. The study sites encompassed a range of savannah conditions which resulted in the wide range of overstory crown closures. All study sites were located south of the Missouri River within Knob Noster State Park, Ha Ha Tonka State Park, Meramec State Park, Taum Sauk Mountain State Park, University Forest Conservation Area, Peck Ranch Conservation Area, Bennett Spring Savannah and the Mark Twain National Forest near Fort Leonard Wood.

Figure 1. Linear regressions of individual rate-of-spread observations and predictions for fuel model 2 and the customized oak savanna fuel model



Input data required for BEHAVE were gathered before the prescribed fire ignitions. Weather, rate-of-spread and flame length were gathered during the burns. Fuel information was collected to develop the customized fuel model for established savannahs.

Results

Fuel model 2 (Timber and Grass) and the Customized Oak Savannah Fuel Model (COSFM) provided the most reliable predictions of prescribed fire rate-of-spread (ROS). Fuel model 1 (Short Grass) and 3 (Tall Grass) consistently over-predicted ROS. Fuel model 9 (Hardwood Litter) consistently under-predicted ROS.

Fuel model 2 and the COSFM provided reasonable ROS predictions for both individual and mean ROS. Ninety percent of individual predictions using both fuel models were within +/- 10 chains per hour (chns/hr) of the observed ROS and 97% of the individual predictions using both fuel models were within +/- 15 chns/hr of the observed ROS (Figure 1). The variability was due in part because the model was developed to provide a general estimate of fire behavior under model assumptions.

To reduce this variability, mean ROS by site was compared to BEHAVE predictions using Fuel Model 2 and the COSFM and they were found to be reasonable. Five of seven mean ROS predictions using Fuel Model 2 were within +/- 2 chns/hour of the observed mean ROS. BEHAVE underestimated the other two mean ROS observations by 6.8 chns/hr. All the mean ROS predictions using the COSFM were +/- 5 chns/hr (Figure 2).

Conclusions

BEHAVE reliably predicts prescribed fire mean ROS in established oak savannahs if the appropriate fuel model is selected and accurate information is entered. Fuel Model 2 and the COSFM are appropriate for established savannah fire behavior predictions while Fuel Models 1 (Short Grass), 3 (Tall Grass) and

9 (Hardwood Litter) were not appropriate. Fuel model 2 is readily available within the BEHAVE program.

When using BEHAVE in established oak savannahs or in other fuel situations, it should be used as a tool to provide information to fire managers so they can assess the likelihood of meeting their burn objectives.

Recommendations

To estimate oak savannah fire behavior in Missouri with BEHAVE, we recommend:

1. Use Fuel model 2 within the BEHAVE program,

2. Make multiple predictions using various slope and wind data that are reasonable considering the topography, weather and fire prescription,

3. Estimate fire behavior for potentially volatile areas within a burn unit,

4. Use BEHAVE on fuels adjacent to the burn area to estimate fire behavior and suppression needs in case the fire escapes control lines, and

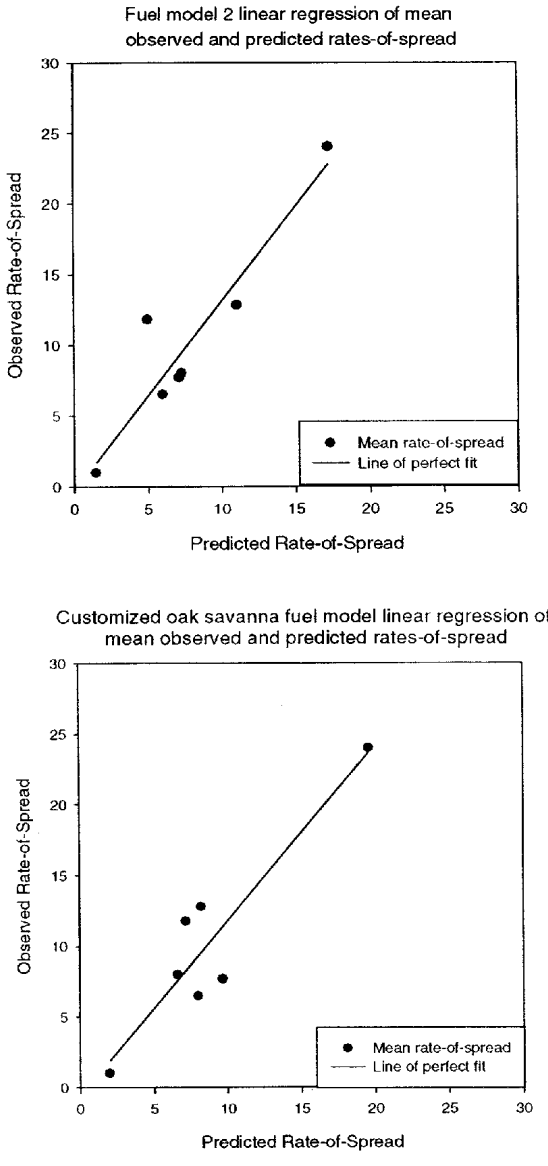
5. If actual field observations are inconsistent with model predictions then check the input data.

Using BEHAVE Models on Other Than Oak Savannahs

The results of this study should not be broadly applied to predictions using other fuel models in other fuel types.

When BEHAVE is used under fuel conditions where model reliability is unknown, do not assume that the model s predictions are valid. Estimate fire behavior and then compare the observed to the predicted parameters. If the input data is correct and the model predictions are inconsistent with observed fire behavior, the fuel model may be incorrect. Select another fuel model that resembles the fuel type you are burning. Compare the fire behavior predictions to observed fire behavior of this second model. If the model is still inconsistent, repeat the process. Remember to be flexible when using fuel models; fuel models that are similar to the fuel conditions are most likely to predict accurate parameters but when similar fuel models are not working, experiment with the other fuel models available within the BEHAVE program.

Figure 2. Linear regression of mean observed and predicted rates-of-spread for fuel model 2 and the customized oak savanna fuel model



Principal Investigators

Keith Grabner, Biological Science Tech.,
USGS, BRD, Missouri Field Station,
Columbia, MO

Dr. John Dwyer, Associate Professor,
Department of Forestry, School of Natural
Resources, University of Missouri, Columbia

Dr. Bruce Cutter, Associate Professor,
Department of Forestry, School of Natural
Resources, University of Missouri, Columbia

This project was funded through the
University of Missouri - Columbia, by the
Missouri Department of Conservation s
Forestry Division.

Invitation for Submissions

Authors are invited to submit manuscripts for Notes For Forest Managers. Notes should be field oriented and be relevant to forest land management. Submissions may be sent to:

Forestry Research Section
Missouri Department of Conservation
1110 S. College Avenue
Columbia, MO 65201

Notes For Forest Managers are also posted on the Missouri Department of Conservation web page at <www.conservation.state.mo.us>.